User experience proposal for mobile interactive experiences in cultural heritage and learning

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ABSTRACT
Nowadays, tourists' experience can be made highly interactive with the proper tools and technologies, such as augmented reality. While mobile augmented reality applications for tourism, cultural heritage and informal learning are not an absolute novelty, there is a clear need for improving the user experience of these tools. In this paper, we present a proposal for a redesign of the Spotlight Timisoara AR application, towards an app that incorporates both visual guidance through augmented reality and immersive learning functionality. The proposal is in the form of a clickable prototype, which was tested with real users. We describe the results of the implementation and testing of the proposed application.

Author Keywords
Augmented reality; user experience; cultural heritage; m-learning; mobile applications.

ACM Classification Keywords
CCS Concepts: Human-centered computing → Human computer interaction (HCI) → Interactive systems and tools

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INTRODUCTION

In terms of augmented reality (AR) relevance, researchers talk about the endearing potential of technology growth and user stimulation to explore documents beyond the obvious perspective and, thus, serve more than one purpose at once [1].

Research in virtual tourism and education raised expectations of the partial environment control passing to the user. From the virtual environment and reality level used in the released applications, we see that users have affective, cognitive, and sensing experiences [2], and some are even aligned with learning principles.

Research in virtual learning, on the other hand, shows a more documented users' experience with AR mobile interfaces. Newest advancements of content, alongside wireless devices (ex. smartphones, tablets) evolution, broaden the applicability of virtual learning towards AR m-educational applications. There are 3 aspects of m-learning [3], [4] that have a direct impact on the learning motivation: Correlation between real and social world environments [3]; UI and UX for mobile - an appealing, easy to use application sells as it covers a much wider footprint of possible users; Learner-generated content, as well as context. The main key factors [3], [4] identified are: complexity of the environments; an open, adaptable, and agile environment; dynamic (rapid and complex) tools; frameworks diversity.

In this paper, we describe the implementation and testing of a clickable prototype of a redesigned version of the Spotlight Timisoara AR application[1], aimed towards interactive guidance for tourists and immersive learning of the cultural heritage of the city. Our goal is to demonstrate that technology – AR in particular – can create a bridge between generations and can increase the awareness towards qualitative and productive human interactions, stimulating constant informal learning.

Spotlight Heritage Timisoara is a digital cultural initiative of the Politehnica University of Timisoara, realized in partnership with the National Museum of Banat, part of the Timisoara European Capital of Culture program. Spotlight Heritage Timisoara reveals, by digital storytelling, the city of Timisoara through stories of cultural and historical heritage, technical development, communities, and neighborhoods, interwoven with the personal stories of the inhabitants of yesterday and today [5].

AR/VR interactive cultural heritage

The flexibility level of the current released applications allows users to visit places virtually (ex. indoor and outdoor) and interact with virtual environments through various techniques, before, during or after the actual visit. The use of such technologies and methods of access determined further research in the following directions [2]: ensuring an ideal and intangible UX, watch pre/during/post timing visit, use relatable backgrounds (like the 3D ones). Providing a better user experience, by creating a comfortable design for the user, is possible and will result into more new but also recurrent customers.

The user experience could be improved by designing the UI (user interface). The design of the application is important because the visual aspects play a significant role and add

[1] https://spotlight-timisoara.eu/en/mobil-ar-vr/

value to the user experience. Providing a positive user experience makes the user buy and use the product. Offering an optimized user experience to all users is a key element in the final decision of the applied product. The user experience could be designed to have an expected impact on the target users interacting with the product, so how the application works is significant [6]. There are several factors that are very important when developing an application: data security, product marketing, visual components, ease of use and design clarity [6].

In order to design an AR tourist faceted user interface, we must take into account: screen components, navigation modules and data modules. Simple and efficient design of the user interface is essential. Things that can be confusing must be eliminated. Establishing consistency and common design elements provides the best user experience.

The use of typography and transparency will bring several design advantages, such as readability [6]. In-depth knowledge of user requirements, capabilities and constraints needs to be concentrated. User experience professionals need to focus on usability to improve application success. UI designers, UX professionals and researchers, marketing teams and others need to work collaboratively. The usefulness and satisfaction of the product determines the user experience.

People like to interact with products that meet their requirements and that are light and pleasant. Companies are confident that a good user experience has a big impact on sales, because a good user experience improves customer satisfaction.

AR interactive m-learning

The dynamics of the modern world led to a new and competitive environment of augmented tourism. The tourism business is always trying to keep up with the times and intensify the game with new technology touches [7].

Augmented reality (AR) in tourism, has a great potential to enhance the travel experience, as the industry currently needs both technologically integrated as well as value-added services, which are dynamic, interactive and entertainment focused. AR proves to be a technology that can provide tourists and citizens with much more personalized content and services tailored to their needs [8]. AR technology is an integration of the real world and the virtual world, to provide additional information about something in the real world with information displayed in the virtual world.

In the case of the building, additional information could be about historical data as well as old pictures / videos about the building. In the case of the tourist objective, the additional information could be about taking pictures with different effects, or how to explore that objective by overlapping the missing parts, to transform it into what it was in the past.

AR can revolutionize tourism, by previewing, planning, and accessing location-based information holiday destinations from different places. Users can preview and book their hotel, access information at sight, navigate the perimeter, translate written or spoken signs or conversations, locate entertainment options, all through a mobile app [8].

Examples of AR cultural heritage applications

Based on the article provided by ZealAR [9], we discovered several applications developed with augmented reality technologies, similar to the proposed prototype.

A first application of this kind is called "World around me"[2], it is a free application for both iOS and Android, and through it, it helps users locate restaurants, museums, hospitals, stores, gas stations, temples and more and gives users the directions they need to get to the place / location they want. All this is done through augmented reality, which gives users all the information they need, but also through the classic map, provided by Google Maps.

Another free application, available only for Android, which deals with places of interest for travelers in Spain is "Senditur"[3]. It is also an application based on augmented reality, through which users can discover the cities and mountains that are close to them and offers all the details that may interest them about that place (including historical information). It is specially designed for hiking and mountain trails, but also offers the possibility of locating pharmacies and guesthouses. An essential function of this application is that it works both online and offline.

"Smartify"[4] - through this application, the mobile phone is directed to a work of art and its history is discovered in a totally different way, due to the implementation of AR. The following museums that have implemented this functionality: the National Portrait Gallery and the Royal Academy of Arts in the United Kingdom; San Donato Museum in Italy; Metropolitan Museum of Art (New York); J. Paul Getty Museum (Los Angeles); Laguna Art Museum of Contemporary Photography (Chicago) in the United States and the Reina Sofia Museum in Spain.

"Outdooractive"[5] allows the discovery of mountain routes, download road/ski maps with the use of the phone camera, which identifies AR elements.

"AR City" is an application for both tourists and locals, which guides users in a city. It is one of the creations offered by Blippar [10], which uses the elements of augmented reality. This application helps users navigate the urban environment, indicating which road they should

[2] https://worldaroundmeapp.com/

[3] https://www.senditur.com/en/

[4] https://smartify.org/

[5] https://www.outdooractive.com/en/

follow, the names of the streets and the most remarkable places, all through the application. The application has several important elements on which it is based: it provides a visualization of walking routes through augmented reality, makes AR overlays of information related to the user's location - for example streets and points of interest, and recognizes, positions and indicates directional information by computer vision. Currently available only in central London, San Francisco and Mountain View, being available on both Android and iOS.

"Guideo"[6], which helps users access a route, and their position will appear on the city map, completely geolocated, following the route of the tour selected to be displayed. By pressing the 3D button and activating the camera of the mobile phone, they can focus on a specific point of the place where they are and complete the reality around them, with a monument that no longer exists, historical or mythological characters, traditional scenes and more. This app also provides information about where the user is located. These stories are complemented by texts, images and videos that were considered of interest to make the story offered by the application as attractive as possible.

Examples of AR m-learning applications

When it comes to AR/VR focused interactive learning there are some problems that need to be taken into consideration. In [4], the authors take into consideration ethical and health as two of the direct implications of these technologies. By those means, the authors try to introduce the concept of design-based research or DBR, for short, which "embeds iterative project design and evaluation" [11] in the scope of enlightening the birth of new and refined design principles, that can be molded onto academic contexts [3].

The authors talk about a 2-year conducted study on New-Zealand young generations m-leaning capabilities and their direct implications of the used tools, in order to understand how theoretical, methodological and practical aspects of classical learning are transferred into the digitalized mobile environment, through mobile AR.

They thus concluded that the pass has not been smooth due to the lack of settings abuse, meaning that either the users have not been using the applications to their fullest due to various reasons, or that the implementation of the apps did not meet the UX/UI standards desired by the users.

In [3], the authors focus on the role of positive emotions in AR environments. The study was done on a guided historical tour and the users (all undergraduate students, from a prestigious North American university) engaged using mobile AR applications. The collected data engaged two possible real-life situations: indoor and outdoor environments. While comparing the two premises, researchers identified several differences: that the outdoor learning was perceived as less boring and more enjoyable, than the indoor one, due to the relatability of the environment and corelated freedom. Thus, the AR applications' effectiveness in different contexts (virtual vs location-based) has a huge impact on the learning capability. AR methods of learning come as a supplement to the classical ones and enhance the theoretical part with a practical one [4], [11], [12].

On a more complete level, the authors [11] talk about what types of information are displayed in such apps and retain the search to the following: historical pictures, audio tours with historical timelines, video tours of historically information. The authors analyzed the results generated by these actions and implied that the understanding of the materials used in the application is crucial to the determination status of the process (success/failure). On the same note, in [13], the authors discuss about House of Olbrich, another app that is used as an architecture tourism guide for cultural heritage sites. It is used to offer interactive hotspots on buildings, spots that display detailed multiple types of multimedia content (instructional videos, how people lived, social events, games, short multiple-choice assessments) about that building.

In [14], the authors go deeper with their research and propose ArkaeVision, a web based, gamificated, AR cultural heritage application. For the first time, authors come up with the idea of passing the power of decision to the users and thus guarantee them unfenced guidelines or predefined visit path. This user rights strategy is guided by a user-centric interactive approach, that relies on instant rewards and gamification in order to stimulate the users' desire for a constant and progressive discovery. The gamification underlined in the paper shows characters paperless solution to digital-human interaction. ArkaeVision is based on 3 ideas: Potential of Cultural Heritage and Tourism application, Platforms typologies suitable for AR apps and Types of users and their needs-according to the envisioned experience [14]. Even though the entertainment business related apps have grown in popularity, the entertainment business is not the only domain that has experienced this phenomenon. On the same list and with a similar impact there seem to be the interactive mobile or web applications (with accent on mobile devices primarily), which children and adults use in order to educate themselves about certain topics: car fixes [12], medicine [15], art [16], history [17], [18] or culture.

For AR m-learning applications, scientists conducted studies [14] show parameters extracted from the UX processes of object display and evaluation, properties of the phone and camera, and recommendation for both targeted users single and simultaneous users.

During their study they discovered that between Cultural Heritage and Tourism there is a strong bound that, if used correctly, can boost the number of both local and national tourists. Authors imply the presence of multiple interface

[6] https://apkpure.com/guideo/com.bookguideo/

layers into their ArkaeVision Archeo app [14]: Environmental, Experimental, Educational.

The entertainment business entered strong on the AR learning app market through various domains including touristic applications such as SpotlightAR or Gatwick. Since 2000, there are several AR apps for various Cultural Heritage and learning purposes, like [17], [18]: Olympia - allows visitors to walk along the ancient city looking at its original buildings beside archaeological remains; Marq short of Mobile AR Quest - focuses on teenagers and old people, and is an immersive educational game; Carnuntum App- historical 3D journey, Museum of Celtic Heritage - a Celtic warrior avatar, that appears after scanning, and tells stories about the artefacts; Lumin - a Google based technology for Simultaneous Location and Mapping (SLAM - Project Tango); KeyARt - an image recognition app that gives the user the ability to make a virtual tour of famous museums (for example, Louvre, the Metropolitan [17], the Vatican Museums [18]); The Speaking Celt - an immersive avatar guides and tells stories about the artefacts. These applications provide an innovative AR approach to social and learning experiences. There are several applications, as well as several approaches, but most of them revive in the historical field. The apps promote interactive social and m-learning experiences but have poor learning material diversity as well as intellectual and social inclusion.

To conclude, we found that the lack of cumulated diversity in terms of IQ levels, gap between generations, as well as modern ways of evaluation, are a proper reason for further research.

DEVELOPING AND TESTING AN AUGMENTED REALITY APPLICATION

In this section, we describe the implementation and testing of a clickable prototype of a redesigned version of the Spotlight Timisoara AR application, aimed towards interactive guidance for tourists and immersive learning of the cultural heritage of the city. The newly improved interactive prototype aims to attract both the elder generations as well as the younger ones.

Proposal for the User Interface

We propose the UI of a prototype for an AR app, that should fill up the unexploited user needs and desires regarding immersive cultural heritage and interactive learning applications, that integrates better into society needs.

We took 2 main principles – one old ("Divide and conquer") and one new ("Gamification") – and combined them to create a new UI. Our main contribution is thus based on the reinterpretation of the classical apps for maps and directions, stretched upon accessible icons and clear directions, in such a way to diminish awkward interactions and language barriers in terms of learning and digitalization. UI counts hard in the usability and learning process. We thus choose a vibrant look with bold colors and undertones. The fonts and icons have been chosen using specialized online tools and adjusted in AI for a proper fit.

The application's main purpose is to discover nearby touristic attractions and offer assisted guidance. The application has two main parts: the virtual guide, that explains the users the steps one must make for a proper use, and the actual use of the application. The guide is always present along the user journey and comes in the form of a gamified avatar named Slight.

Figure 1. Slight – the gamified guide

Before entering the guidance mode, the app needs the user's acceptance to access the camera. The user must follow steps 1 to 4 to get an overview of the provided services.

Steps 1, 2 and 3 require the user to raise the phone in eye-sight level and move it from side to side to trigger the scan.

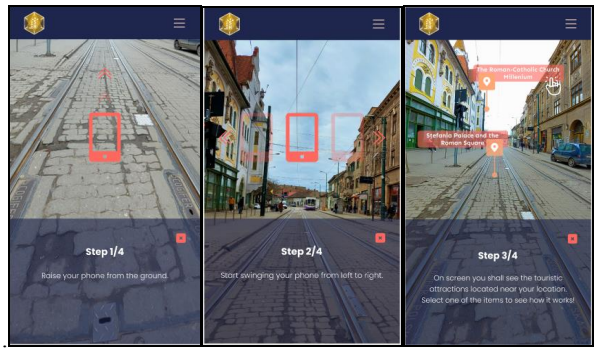

Figure 2. Application tutorial

If two sights appear on the screen simultaneously, the users can select either and proceed with the trail. The selection leads to display of additional information for the building (number of kilometers and the walking time to destination, name, etc.).

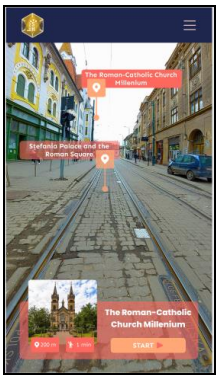

Figure 3. Sight selection and information display

After choosing which objective they want to visit, the users press the "START" button. The application will guide them, with the help of the AR arrows, to the place of interest.

Figure 4. AR route assistance

With the help of the arrows that will appear on the screen, the route to the sight will simplify. In order to be sure that the users have reached the desired place, an indicator with the name of the landmark they have selected will appear on the phone screen.

Figure 5. Tag identification

Step 4 in the application gives instructions upon how the embedded camera has to be used for a proper scan.

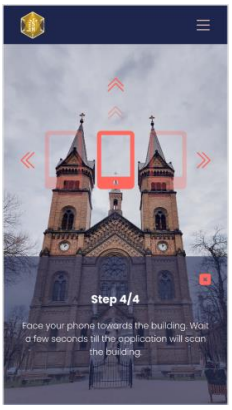

Figure 6. Building scan

In this stage, the application is scanning the touristic objective to display the main features of the app: photo and video gallery, AR content and Quiz (designed for both entertainment and educational purposes). In order to do so, the user needs to move the smartphone from side to side in order to trigger the scan. Meanwhile, the application displays a message that informs that the process might take a few seconds to complete.

Figure 7. Gamified service display

The Photo and video gallery display old photos and current video recordings of the tourist attraction.

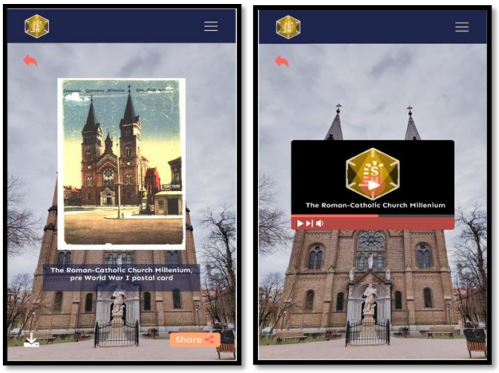

Figure 8. Photo and video gallery

The AR overlaying effect is designed to overlay a historic photo of the building, on top of what the camera is seeing, with the help of AR technology. The users can see machete of the old building on top of the current views.

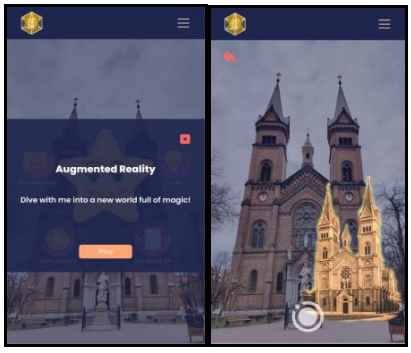

Figure 9. Augmented reality service tab

Fun mode on – the application is equipped with 6 filters and one distribution gate that connects the app with the most used social networks.

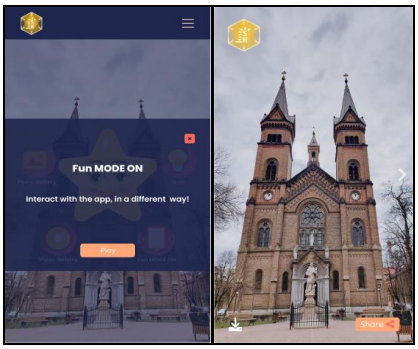

Figure 10. Fun Mode ON

Through this, the users can share picture taken at Photo gallery level and/or the postcard from the AR level to share with their family and friends for a much deeper cultural connection. The elements can as well be downloaded if the users opt for an offline storytelling of the cultural events.

Figure 10. Personalized effects

Quiz – consists of 3 main questions, each with 3 possible answers, from which only one is correct. When the questions are answered, Slight (the avatar) displays the same message, regardless of the outcome of the quiz and lists a series of encouraging messages, as well as a list of the correct answers to the popped questions, regarding of the user's previous choice.

Recent psychology studies have shown that negative statements, compared to positive criticism [19], [20], lead to negative emotions and thinking, and decrease the rate of one's evolution. In addition to that, researchers [21] have proven that repetition of the „learning material" helps the one that studies it to learn it faster and remember it for a longer period.

Humor plays another role in supporting the memorization process, as it reacts as an outside stimulus that triggers the brain [22]. In other words, if we use humor, short questions and positive phrases, and reflect them into the user interface elements, we can create a much pleasant user experience [23].

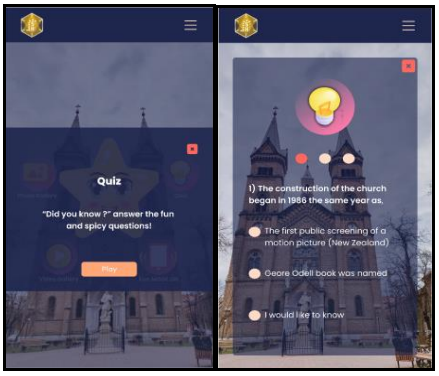

Figure 11. Quiz tab

Testing stage

We conducted an analysis on the proposed prototype considering verbal and behavioral clues from the users. The interviews were conducted on 12 participants, divided into 3 different types of users (Local persona, Student, Tourist), from Romania, United States and Sweden. 75% were women and 25% were men, all with a large age range, from young teens in their 10s and young adults in their 20s to mature adults in their 40s and 50s.

We used a 3-step method: pre and post questionnaire, and a semi structured individual interview. In the pre questionnaire, the participants answered questions about their previous experiences with AR cultural apps, advantages and disadvantages. One major role in the pretesting stage has also been the residential country of the participants, as we inclined towards a variety of opinions and sustainable cultural background.

The second step was the semi structured interview where users had to follow scenarios and complete the tasks. The

scenarios focused on finding the route to one objective and discovery and use of gamified elements. From the post questionnaire, we extracted the users' impressions about the use of the application.

RESULTS AND DISCUSSIONS

In order to come up with reliable intel, we analyzed their work, taking into consideration both verbal and behavioral information. Overall, all the participants managed to complete all the tasks successfully, and were generally satisfied with the app. Even so, there are more information that we need to take into consideration, as the testing stage provided helpful information and relatable feedbacks. On a general note, the selected participants were intrigued by the proposal of the graphical interface of the app, and even more about its potential of improvement.

Experienced adults had much harder times completing the tasks, unlike the teens and young adults. In addition to the „age gap", the experienced adults tended to incline towards a „Did you know that?" section (already implemented by the big documentary channels like Travel, DigiAnimalWorld), rather than a Quiz one, due to the association they make with their early school days.

All the participants to the study seemed to agree on two matters: a multilingual app is a must and video gallery is a huge plus. They unanimously stated that the implementation of the app in various popular languages is a must, to increase the number of potential tourists, on one hand, and attract the minority groups, on the other. Some of the users suggested a video transcript, as it can empower the people with hearing deficiencies. The participants were also interested in the improvement of the AR section with more engaging effects.

DISCUSSION

The development of technology and the emergence of the 5G network allows us to think about possible extension of this immersive m-learning prototype into 2 unexplored branches: extending the app to support users with special needs and exploring VR content.

Just like any app, this immersive m-learning prototype leaves room for further improvements. For this, we took into consideration the results obtained from the literature review, the users' opinions as well as our own experience, to come up with improvements that are both needed and applicable, for both the local and the European citizen.

We suggest the following future improvements: multilingual versions of the app, audio guides and scripts for the video gallery, improvement of the AR section. *Multilingual versions of the App* is a feature that has multiple purposes: Educational [23] – can be used as a study material in history/geography for local foreign high schools; Cultural diversity unification – can teach the local minorities about the city they live, work and study in; Touristic purposes – the app can grow the number of tourists. *Audio guides and scripts for the video gallery* – can help the disabled, like the blind and motor disadvantaged travelers. In order to provide an audiobook that is helpful, we suggest collaboration with dedicated associations like European Blind Union or dedicated companies like dotLumen, a company that „empoweres the blind" with the help of VR glasses. *Improve the AR section* by introducing multiple interactive filters: Color-changing panels that allow the users to play with what color/colors they would like to project on the building, historical figures that tell a short tale or bounce around in historical gowns, animal representations of animals with nearby habitats.

CONCLUSIONS

Based on the selected documentation and performed studies, we understand that the uses of AR and VR have manifested growth in fields like tourism and m-learning through digital improvements in navigation, guides and translations. Their integration facilitates human effort in touristic visits and pre/on and post documentation through improved UI and increase of digital services diversity.

In conclusion, the integration of virtual reality and augmented reality applications in tourism would solve many of the problems we face when setting up a trip. From the points and models discussed in the paper we can say that the scope of AR/VR is vast and very important in a both personal growth and digitalization progressions. The virtual environment can add value to the tourism industry, while technology expansion can create social integration, hope, and more job and research opportunities that will enrich the tourism industry. Users can have all the information they need, simply and easily, if these technologies will be included in the development process of tourism, letting it become an attractive and intellectually fun environment for all types of users.

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